Transpiration studies.—Among the more recent devices for the investigation of the conditions affecting transpiration is the porometer devised by DARWIN,[11] which has attracted the attention of several workers, leading to improvements by BALLS[12] and by JONES[13] resulting in self-recording instruments. KNIGHT[14] then somewhat simplified the device, and later, assisted by LAIDLAW,[15] produced an automatic instrument that is probably better than its predecessors for most forms of stomatal investigations. All agree in measuring the stomatal opening by the rate at which air passes through the stomata with a given pressure. A rather careful study by KNIGHT[16] of the methods to be employed in avoiding errors in the use of the porometer is suggestive to future investigators in this field. Among the interesting results obtained by this method there may be mentioned those of DARWIN, and of LAIDLAW and KNIGHT, who found indications that upon severing a leaf from a stem and allowing it to wilt, a temporary opening of the stomata immediately preceded the closure accompanying wilting.

In a recent investigation TRELEASE and LIVINGSTON[17] have made a comparison between the porometer and the standardized cobalt chloride paper methods, and have obtained results showing a general agreement of data from the two. In the daily march of transpiring power the two are in close accord during the morning hours up to about 8:00 A.M., but from that hour until 11:00 A.M. the porometer index continues to increase, while the cobalt paper index tends to decrease. After 11:00 A.M. the influence tending to decrease becomes evident in the porometer index also. This is taken to indicate that the porometer measures the diffusive capacity of the stomata, but fails to take into account other influences affecting foliar transpiring power. The divergence in the two records, therefore, may be an index of non-stomatal influences upon transpiration. On account of the limited data, these workers are not inclined to press this conclusion, but it appears to be an extremely probable suggestion.

[11] DARWIN, F., and PERTZ, D. F. M., A new method of establishing the aperture of stomata. Proc. Roy. Soc. London B **84**:136–154. 1911.

[12] BALLS, W. L., The stomatograph. Proc. Roy. Soc. London B **85**:33–44. 1912.

[13] JONES, W. N., A self-recording porometer and potometer. New Phytol. **13**: 353–364. 1914.

[14] KNIGHT, R. C., A convenient modification of the porometer. New Phytol. **14**:212–216. 1915.

[15] LAIDLAW, C. G. P., and KNIGHT, R. C., A description of a recording porometer and a note on stomatal behavior during wilting. Ann. Botany **30**:47–56. *figs. 3.* 1916.

[16] KNIGHT, R. C., On the use of the porometer in stomatal investigation. Ann. Botany **30**:57–76. 1916.

[17] TRELEASE, S. F., and LIVINGSTON, B. E., The daily march of transpiring power as indicated by the porometer and by standardized hygrometric paper. Jour. Ecology **4**:1–14. *figs. 2.* 1916.

An investigation upon a much larger scale, resulting in an abundance of data, is reported by BRIGGS and SHANTZ.[18] It was carried on at Akron, Colorado, and the transpiration was determined by weighing plants potted in sealed cans upon the automatic scales recently described by the same authors.[19] Solar radiation, wet-bulb depression, evaporation, air temperature, and wind velocity were also measured, and the relationship between these physical factors and transpiration was shown. The plants employed were wheat, oats, sorghum, rye, alfalfa, and *Amaranthus retroflexus*, the hourly rate throughout the entire day being determined, the number of determinations ranging from 6 for *Amaranthus* to over 40 for alfalfa. The resulting data are expressed in tables and graphs which also serve to express their relationship with the physical factors. Correlation coefficients and method of least squares are also used to analyze these relationships and give some interesting results. Space permits the citing of their final conclusion only, to the effect that their results agree with those of other investigators that plants under conditions of high transpiration do not respond wholly as free evaporating systems, even if bountifully supplied with water. It is interesting to note that none of the plants here studied show the mid-day drop reported by TRELEASE and LIVINGSTON, by SHREVE, and by other observers at the Desert Laboratory.

MUENSCHER[20] has used the method of determining water loss by weighing and then making counts and measurements of the number and size of the stomata of *Phaseolus*, *Ricinus*, *Zea*, *Primula*, *Impatiens*, *Pelargonium*, *Triticum*, and *Helianthus*. He found no constant relation between the number and size of stomata in relation to unit area of leaf surface and the amount of transpiration. He also concludes that the amount of transpiration is not governed entirely by stomatal regulation. His work, however, does not show any explanation for any other control.

In one of the most recent publications upon this subject, by BAKKE and LIVINGSTON,[21] data are given upon the daily march of foliar transpiring power of different leaves of plants of *Xanthium* and *Helianthus*. These serve to emphasize the fact that the control of foliar transpiration by the plant is a complex one, especially as there is a great range in transpiring power among the different leaves of the same plant with considerable variation in time of the diurnal maxima. No very definite relation is established between age of leaves and their behavior, except that the oldest ones always show a low daily range of

[18] BRIGGS, L. J., and SHANTZ, H. L., Hourly transpiration rate on clear days as determined by cyclic environmental factors. Jour. Agric. Research **5**:583–649. 1916.

[19] ———, An automatic transpiration scale of large capacity for use with freely exposed plants. Jour. Agric. Research **5**:117–132. 1915.

[20] MUENSCHER, W. L. C., A study of the relation of transpiration to the size and number of stomata. Amer. Jour. Bot. **2**:449–467. 1915.

[21] BAKKE, A. L., and LIVINGSTON, B. E., Further studies on foliar transpiring power in plants. Physiol. Researches **2**:51–71. 1916.

transpiring power and usually low maximum index values. In addition to the transpiration data, this paper contains a description of an improved apparatus for providing a standard evaporating surface.—GEO. D. FULLER.

Fossil cycads.—The second volume of WIELAND'S[22] memoir on American fossil cycads represents a large amount of additional work on material with structure preserved, and in particular of a new monocarpic trunk from the Black Hills discovered by Dr. N. H. DARTON. It is replete with admirable line drawings and half-tones representing both external form and internal structure. The material is in addition illustrated by 58 superb plates in heliogravure. The whole constitutes an achievement of which American paleobotany may well be proud.

Although the volume is described as systematic in its contents, it contains much that is of interest to the anatomist and the evolutionist. Considerable space is devoted to the anatomy of trunks of cycadeoidean forms, and the fact that the fibrovascular tissues are much more woody than in the living representatives of the cycads is emphasized. This is the consequence of the narrow rays and the sparse parenchyma, both features of contrast to the living cycadean cylinders. The author apparently has not found in American Mesozoic material the interesting reduplication of the central cylinder recently described by STOPES in a publication of the British Museum. This situation is interesting as it tends to discredit the hypothesis of WORSDELL that the reduplication of the cylinder in cycads is a vestige of the complex system of fibrovascular bundles found in certain species of *Medullosa*, etc. The situation in fact is comparable rather with that found in vines, and it is interesting to note in this connection that it is not improbable that the cycadeoidean genus *Anomozamites* was a climbing plant. The author emphasizes the statement that the mucilage cavities of the cycadeoidean forms were isolated cysts and did not constitute a system of canals as in living cycads.

Certain interesting statements are recorded in regard to the leaves, although most of these represent only elaborations of facts already known. The leaf trace departs from the cylinder as a large horseshoe-shaped strand which passes directly toward the leaf base, breaking up into numerous bundles in transit. This situation is in marked contrast to conditions in the living genera where numerous strands take their exit from the cylinder for each leaf and pursue a circuitous course through the cortex toward the leaf base. It is obvious that the cycadeoidean forms, so far as their anatomy is known, were unilacunar, that is, there was a single gap in the cylinder of the stem for each foliar supply; while in the living Cycadales the vascular system of the leaf is multilacunar. The cycadeoidean condition is obviously more primitive, as it is found in the reproductive axis and occasionally in the seedling of living forms. The ana-

[22] WIELAND, G. R., American fossil cycads, Vol. II, Taxonomy. Carnegie Inst. Washington, Publication 34. 1916.